AMERICAN MUSEUM NOVITATES

Number 566 Published by THE AMERICAN MUSEUM OF NATURAL HISTORY New York City Sept. 21, 1932

56.6 (118:82,9)

THE SUPPOSED ASSOCIATION OF DINOSAURS WITH MAMMALS OF TERTIARY TYPE IN PATAGONIA[1]

BY GEORGE GAYLORD SIMPSON

Over a generation has passed since Florentino Ameghino startled the scientific world by announcing that in Patagonia highly developed mammals, including ungulates, such as elsewhere occur only in the Tertiary were contemporaneous with dinosaurs. At first he based this radical opinion on apparent conformity between the dinosaur beds and the generally superposed mammal beds and on supposed cases of actual association or of superposition of dinosaurs over mammals reported by other workers, especially Roth. Later (1906) F. Ameghino announced that his brother, don Carlos, had now found dinosaurs associated with the *Notostylops* and *Astraponotus* faunas.

These discoveries could only be interpreted in one of three ways: (1) The repeated observations were erroneous, or (2) dinosaurs survived into the Tertiary in Patagonia, or (3) mammals comparable in degree of evolution with those of the Tertiary in the rest of the world there lived in the Cretaceous. Ameghino never hesitated between these alternatives. To him these faunas were Cretaceous, and largely on this basis he built a series of elaborate theories, inevitably destined to revolutionize current scientific opinion if found correct. The essence of his view was that Patagonia was the great center from which mammals spread to the rest of the world, but there are also involved almost equally far-reaching views as to phylogeny, palæogeography, molar evolution, and kindred subjects.

With the partial exception of Santiago Roth and some other authorities working in Argentina, this belief has not been shared by other students. The general attitude has been that the observations might be false, and that if true the more reasonable conclusion is that dinosaurs survived beyond the Cretaceous in Patagonia.

In view of the extreme importance of the problem, it is unfortunate that no really serious and adequate attempt to settle it one way or the other has hitherto been made. The literature is large, to be sure, but it is often lacking in factual basis. Much simply denies the possibility or

[1]Publications of the Scarritt Patagonian Expedition, No. 5.

probability of such a thing and questions the accuracy of Ameghino's work. This is neither just nor useful. After the closest study of much of the field and office work of the brothers Ameghino, I am glad to testify that their records of actual observed fact are almost invariably trustworthy. Discrepancies, admittedly frequent, are generally due to differences in interpretation, not in observation. The positive statement that Carlos Ameghino found dinosaurs in the *Notostylops* and *Astraponotus* beds cannot be brushed aside merely because it seems improbable.

Other criticisms may generally be reduced to the statement that later workers have not repeated the recorded discoveries. To these criticisms Ameghino replied truly that one positive observation outweighs innumerable negative statements, and it may be added that no determined and unprejudiced effort to repeat the observations had been made. The *Notostylops* beds, the crucial point in the geologic column, remained almost unstudied save for the Ameghinos' work.

One of the chief aims of the Scarritt Patagonian Expedition of 1930–31 was to reëxamine this whole matter and to attempt to settle it as definitively as possible. To this end over seven months were spent in Patagonia, most of the time being devoted to the uppermost dinosaur-bearing beds and lowest mammal-bearing beds. All of Ameghino's localities and some others were visited, measured profiles taken, and a large collection made. About six months were then spent in Argentine museums studying the Ameghino and Roth Collections as well as the literature. So far as the results bear on the immediate problem of the association of dinosaurs and mammals, they are here summed up. The quite different, less important and simpler problem of the supposed existence of Mesozoic mammals in beds of undoubted Cretaceous or earlier age has been considered in a previous paper. Special acknowledgment of aid and coöperation is due to Drs. M. Doello Jurado, Luís M. Torres, and Angel Cabrera.

RÉSUMÉ

The principal points of inquiry are as follows:

1. Stratigraphic evidence of concordance between dinosaur- and mammal-bearing beds and of the boundary between the two.
2. Examination of individual records of supposed association of dinosaurs and mammals or superposition of dinosaurs over mammals, to determine
   a. The real stratigraphic positions of the fossils in question, and
   b. Their correct taxonomic determination.
3. Efforts to repeat these observations at the given localities.

The results reached are:

1. Mammals of Tertiary type do occur in beds called "Upper dinosaur beds," but this merely shifts the dinosaur-mammal boundary and neither demonstrates nor suggests an actual association. In any given sequence, a considerable interval invariably separates the two, and in this interval there are always erosional unconformities, possibly local, but any one of which may be regional. Continuity cannot be established on lithologic or stratigraphic grounds, and the series is in all probability usually or always discontinuous.

2a. Except in the case of Carlos Ameghino's own observations, the evidence of stratigraphic position of the crucial specimens is certainly not worthy of belief. Carlos Ameghino's determinations of the horizons from which his specimens came are almost surely correct.

b. But the identification of the fossils from the *Notostylops* and later beds determined as dinosaurs is either positively false or so improbable as to merit only erasure from the record.

3. Work at the critical localities, comparable to or even exceeding that involved in the original discoveries, has failed to produce any positive evidence of the mooted association or to repeat the observations of the workers considered unreliable. It has repeated almost exactly the observations of Carlos Ameghino, but lends no support to the interpretations of Florentino Ameghino and suggests alternative interpretations.

STRATIGRAPHY

The Cretaceous-Tertiary stratigraphy of Patagonia is a very complex subject involving far more than the question here considered, and detailed discussion is deferred. Here are presented some preliminary conclusions and observations, the detailed evidence for which will later be given *in extenso*.

The general stratigraphic series of the meseta region west of the Golfo de San Jorge, is shown on page 4.

No one has denied that the Salamanqueano and all below it are pre-Tertiary, nor that the *Colpodon* beds and all above are post-Cretaceous. The stratigraphic problems here raised chiefly concern the presence or absence of unconformities in the intermediate series and the division and palæontological character of the strata between the Salamanqueano and the *Notostylops* beds. The local and dubious non-fossiliferous "Argiles Fissilaires" are not here of great moment.

Almost all authors have considered the sandstones and clays above the Salamanqueano and below the *Notostylops* beds or (where they occur) the "Argiles Fissilaires" as all of Cretaceous age and as containing dinosaurs and no mammals. They were called the upper beds with dinosaurs, "estratos superiores con dinosaurios," by Windhausen and considered as essentially part of the great Chubutiano series ("estratos inferiores con dinosaurios") more or less incidentally differentiated by the Salaman-

LATER TERTIARY AND QUATERNARY
(here relatively unimportant)

Patagoniano–Marine, probably late Oligocene or Miocene

Colpodon beds (perhaps in part equivalent to the lower Patagoniano).

Terrestrial Tuffs, with at least four distinct mammalian faunas of Tertiary aspect.

Pyrotherium beds

Astraponotus beds

Notostylops beds

"Argiles fissilaires," local, non-fossiliferous, of doubtful age and relationships

Chiefly sandstones and clays, not subdivided by previous work. The "Pehuenche" or "upper beds with dinosaurs" of most recent authors, not the Pehuenche of Ameghino in this region.

Salamanqueano-Marine, probably Senonian, surely Cretaceous.

Very thick and varied continental deposits, the Chubutiano of some recent authors, variously but not yet definitively subdivided. Containing dinosaurs and partly or wholly Cretaceous.

queano marine invasion. Others call them "Pehuenche," implying (on evidence surely inadequate and probably false) correlation with the dinosaur-bearing beds sometimes given that name in Neuquén. All through the literature one finds repeated assurance that they are a unified series containing dinosaurs. This, in the first place, proves to be an unwarranted assumption and in part quite incorrect.

It seems certain that near the center of the great San Jorge basin[1] there are actually terrestrial Cretaceous beds above the Salamanqueano, for here there is evidence (from well records near Comodoro Rivadavia) of a post-Salamanqueano but still Cretaceous marine invasion, above terrestrial sediments. This will be considered in more detail elsewhere, the present point being that in the "Pehuenche" exposures it is possible, I think probable, that some of the lowest sandstones are really Cretaceous, but certainly not all of them are, and in some sections these Mesozoic beds may be thin or absent. Despite repeated assertions, there is a singular lack of real evidence for the occurrence of dinosaurs here. I

[1] A general and perhaps not strictly accurate term meant to include roughly the large area between Bustamante and Puerto Deseado along the coast and extending westward nearly to the Cordillera.

have been unable to find in the literature or by personal communication a single instance of the discovery of an indubitable dinosaur surely in its original burial place in these strata.

The usual evidence is a citation of Ameghino, but the authors fail to note that these are not the beds that Ameghino called "Pehuenche" in this area. He used that name for the beds immediately *below* the Salamanqueano, the summit of the Chubutiano of recent authors, unquestionably containing dinosaurs and surely of Cretaceous age, but not (even according to Ameghino) containing mammals.

There are several records demonstrably false or too vague for serious consideration. An example is the supposed presence of dinosaurs in the "Pehuenche" near the source of the Río Chico at Lago Colhué-Huapí. As shown by Feruglio and Piátnitzky (personal communication and Feruglio 1931, p. 21) these are actually in the Chubutiano, their true position superficially masked by the presence of a fault. Another instance is a dinosaur bone now preserved in the sample department of the Yacimientos Petrolíferos Fiscales at Comodoro Rivadavia said to have come from near Pico Salamanca, where no Chubutiano is exposed, but not found in place and not accompanied by credible confirmatory data. In other cases the level of the dinosaurs found is not determinable in relation to the Salamanqueano and hence of no definite value.

The most reliable record also relates to the region of Pico Salamanca; Huene (1929, pp. 13–14) says ". . . He podido hacer . . . cortas observaciones . . . entre el *Pico de Salamanca* y *Punta Peligro*. . . . En la gran región bañada inmediatamente al norte del Pico de Salamanca; son bien conocidos los 70 metros superiores de las capas de Pehuenche. En gran parte esta sección se compone de arcillas de un gris-blancuzco, constituyendo principalmente dos grandes conjuntos, sub y sobrepuestos, y además cortados en el medio por areniscas blancas, a veces muy gruesas, con fragmentos de huesos y troncos de árboles silicificados. En la arenisca superior hallé aún una garra de saurisquio. . . . (No he visto nada que pueda determinarse fuera de la garra mencionada y tampoco ésta puede ser determinada con precisión)."

This seems by far the most trustworthy record, and it is very possible that there are true terrestrial Cretaceous beds above the Salamanqueano in this area, as well as post-Cretaceous beds of almost identical physical character, but even this record is not definitive. It is accompanied by no positive guarantee as to the determination of the claw, nor any certainty that the level at which it was found corresponds to the actual time when the animal lived. Since the basal Tertiary sands

give every evidence of being redeposited from older sediments, the possibility of derivation of fossils is always to be borne in mind when dealing with such isolated and fragmentary occurrences.

The latest statement on this point is that of Feruglio (1931), whose extensive experience in this area makes him an authority worthy of great credence:

"En realidad, ahora puedo aseverar que ni yo ni mis colegas [of the Dirección General de los Yacimientos Petrolíferos Fiscales] hemos hallado hasta hoy huesos de Dinosaurios en el Pehuenche, o sea en la serie directamente superpuesta al Salamanqueano [and below the mammal-bearing tuffs]. . . . [The author then cites the find of von Huene mentioned above and concludes that it may be a derived fossil] . . . Así que no es del todo improbable que en esta parte de la Patagonia, los Dinosaurios hayan desaparecido antes de la deposición del Pehuenche, o sea durante el Salamanqueano. . . . "

It thus remains to be shown that any of this so-called "Pehuenche" contains dinosaurs. Further, if, as remains quite possible, there are dinosaurs at some places and some levels, this would merely increase the already established probability that the series is not simple, in spite of its usually moderate thickness, but a complex of lithologically more or less similar rocks deposited at two or more quite distinct times.

These sands and clays universally considered as of Cretaceous age until 1931, and still so considered by almost all authorities, do contain mammals. This fact is summarily mentioned in two papers issued since our return to the United States. Piátnitzky (1931) states:

". . . Las areniscas observadas en Cañadón Hondo inmediatamente debajo del complejo tobáceo con mamíferos, contienen también huesos de Mamíferos en dos niveles distintos. Sin embargo, antes de estudiar estos fósiles, sería aventurado llegar a una conclusión con respecto a la edad de las areniscas. De todos modos, su posición estratigráfica muy baja y la semejanza entre su composición litológica y la del Pehuenche propiamente dicho, talvez indiquen su pertenencia al Cretáceo, a la cual época, por consiguiente, deberían referirse los huesos de mamíferos encontrados en las mismas areniscas."

And Feruglio (1931) adds:

"Observaciones recientes del ing. A. Piatnitzky en el valle del Río Chico[1] . . . y del ing. J. Branmayr al norte de Pico Salamanca, han comprobado la existencia de restos de Mamíferos *in situ* en la parte

[1]This is the discovery alluded to in the quotation from Piátnitzky above, Cañadón Hondo being tributary to the Río Chico del Chubut.

superior del complejo continental referido al Pehuenche o Pehuenchiano, a unos 20 m. sobre el banco negro superior y a una altura quizás no mayor de 80 m. sobre el Salamanqueano. Estos hallazgos, junto a las consideraciones que he expuesto arriba, ponen en discusión la edad (terciaria o bien cretácea) del Pehuenche, cuya aclaración puede esperarse de un estudio paleontológico."

We made a collection containing many identifiable specimens at the Cañadón Hondo locality (kindly pointed out to us by Ingeniero Piát-

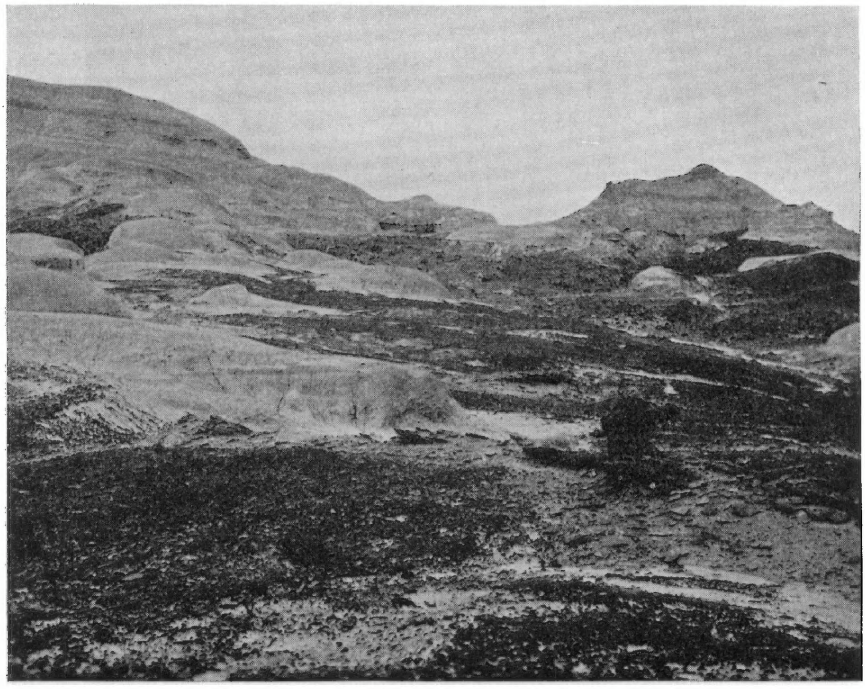


Fig. 1.—In Cañadón Hondo, east of the Río Chico near Paso Niemann. Sandstones and shales commonly referred to the "Pehuenche," but here without dinosaurs and containing Tertiary mammals, some of which were found in the sandstone lens in the right foreground.

nitzky) and we further found mammals at a number of different places in the clay-sandstone series. The lowest were far below those mentioned by Feruglio, less than forty meters above the Salamanqueano. Study is not yet complete, but sufficiently so for present purposes. The mammals are very definitely of Tertiary aspect and close to those of the *Noto-*

stylops beds.[1] Piátnitzky's suggestion of Cretaceous age is not warranted by any evidence save that of lithology, to which I would give no weight at all in this case. It is very usual for a terrestrial formation to have a basal part of material simply *remanié* from an older series and lithologically similar to or identical with the latter. It is the universal experience of all workers from Carlos Ameghino to the present that there are no dinosaurs at least in the upper part of this series. Certainly none has been

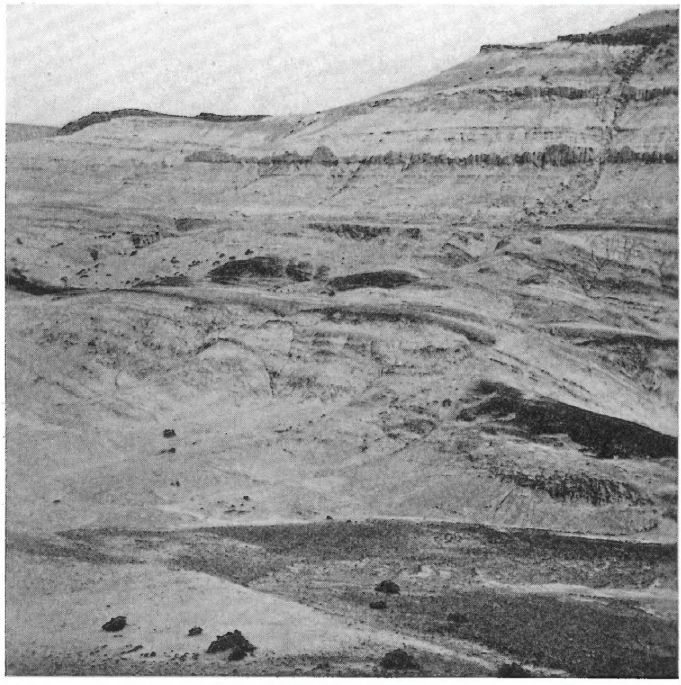


Fig. 2.—Supposed angular unconformity at the base of the Tertiary at Cerro Blanco, along the southern margin of the Cuenca de Sarmiento. The "argiles fissilaires" in the foreground are tilted, and the horizontal *Notostylops* Beds of the main cliff seem to overlie them with an angular unconformity, but this is due entirely to slumping, and the two series are actually parallel.

found at the horizons or the localities where mammals occur, and there is no reason to expect them there. In spite of his belief that he found dinosaurs *in* the *Notostylops* beds (as discussed below), don Carlos is very clear (personal communication) that he found none *below* these beds and above the Salamanqueno or in the "basal *Notostylops* beds."

[1]With unusual felicity Ameghino theoretically considered these strata as basal *Notostylops* beds, although he did not definitely record mammals from them. As in several other cases, later workers have gone astray in their refusal to follow his lead.

The boundary between dinosaur beds and mammal beds is not at the base of the tuffs, where it has almost always been placed. It is either within or below the series now called "Pehuenche" by most authors (which here is not really homotaxial with the dinosaur-bearing Pehuenche of the north). This very important shifting of the boundary has wide stratigraphic, faunal, and structural ramifications to be discussed elsewhere. It does not at all advance the case of Tertiary dinosaurs or Cretaceous ungulates.

As regards the presence or absence of unconformities, Keidel, Windhausen and others have claimed that an angular unconformity occurs at the base of the fossiliferous *Notostylops* tuffs. If confirmed, this would

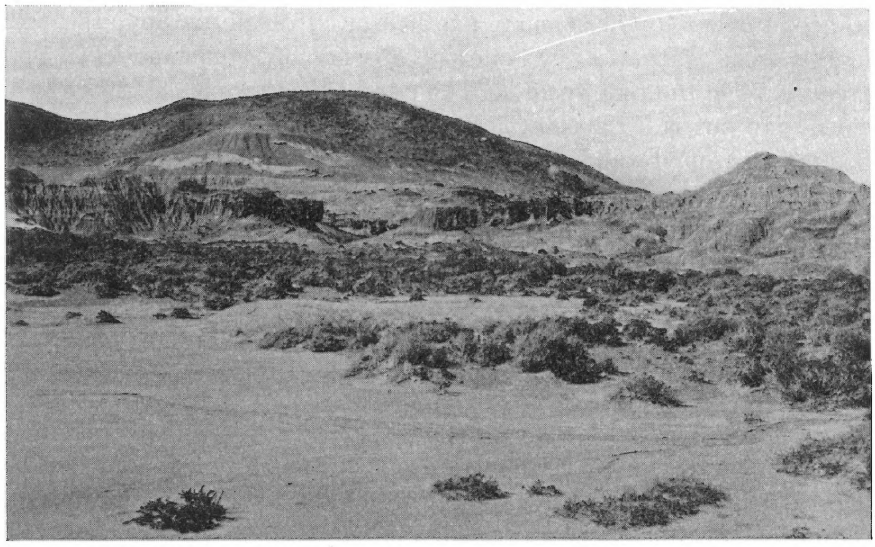


Fig. 3.—So-called "Pehuenche" strata near Punta Peligro, north of Pico Salamanca, showing a characteristic exposure of these fluviatile sediments, with several erosional breaks and an abrupt change from a more brightly colored and more sandy lower part to a paler and more shaly upper part.

not, as they supposed, separate the dinosaur and the mammal beds, but would be within the mammal beds and considerably above the highest level known to contain dinosaurs. In fact, as suspected by Feruglio and as I shall clearly show elsewhere, this unconformity does not exist, or better, is at a very different point in the stratigraphic sequence and does not define a possible Cretaceous-Tertiary boundary. The basal Tertiary and uppermost Cretaceous are essentially parallel in this area.

The major change in type of sedimentation is generally from sandstone and clay to tuff and bentonite and has been thought (on no palæontological evidence) to correspond to the major faunal change. Now this is proven to be untrue. The major faunal change is within or below the sandstones and clays of "Pehuenche" type. In every section examined, there are one or more local, parallel unconformities in this series and minor changes in type of sediments, for instance (near Pico Salamanca) from red or variegated sands with usually minor clay lenses, to thick clays with lenses of pale sands. We have here a continental series with numerous breaks which can be evaluated only on palæontological evidence. It is not valid to follow Ameghino in the belief that the series is continuous. It might be so, but probably is not. As is too well known to need further emphasis, mere parallelism, especially in fluviatile sediments, is no warrant to assume the absence of significant, even very great, gaps in the time record. The purely stratigraphic evidence is inconclusive but is if anything inclined against the inclusion of dinosaur beds and mammal beds in a single formation in any restricted sense of the word.

Much of the discussion regarding the contemporaneity of dinosaurs and the *Notostylops* fauna is merely verbal. One example will suffice. Answering Hatcher's criticism, Ameghino (1903, p. 17) says, "Il [Hatcher] a demandé à Charles [Carlos Ameghino] s'il avait trouvé des débris de mammifères associés à ceux de Dinosauriens, et il lui répondit, non. Si en place de cela, il lui aurait demandé s'il avait trouvé des débris de mammifères dans la même formation qui contient des os de Dinosauriens, certainement il lui aurait répondu, oui." This is clearly and entirely dependent on the use of the word "formation." It is easy to define a formation, as Ameghino did, which will contain dinosaurs (below) and mammals (above), and thus have the two in the same formation, literally, but this does not make them contemporaneous nor does it exclude the probability of a considerable interval between them.[1]

It is, then, unnecessary further to discuss such occurrences in the same "formation" aside from supposed instances of actual field association or superposition of dinosaurs, next to be considered. The newer conceptions of local stratigraphy, here sketched in preliminary outline, change ideas as to the probable Cretaceous-Tertiary contact, but lend no support either to the belief in a single horizon with both dinosaurs and mammals or to the belief in a conformable series with both of these groups.

[1]An analogous case would be the Lance-Fort Union series of our West. These strata could well be, and in some places have been, included in one lithologic formation, which thus could include both mammals of Tertiary type and dinosaurs, but *not* at the same levels.

SUPPOSED INSTANCES OF ASSOCIATION OR SUPERPOSITION OF DINOSAURS

The actual palæontological support for association of dinosaurs and mammals of Tertiary types usually refers to discoveries of dinosaurs in the beds which are characterized by Tertiary mammals, that is, in the *Notostylops* beds (Casamayor Formation) or later formations. These field observations include the supposed discovery of dinosaurs at mammal-bearing horizons and the supposed discovery of dinosaurs in place above such horizons, two types of observations which are essentially the same and, if confirmed, lead to the same conclusion.

These reports I would divide into two very distinct categories as to credibility. First, discoveries by various early workers, usually untrained and demonstrably careless or ignorant, and second, discoveries by Carlos Ameghino, whose intimate and accurate knowledge and generally very careful observations make him a usually very trustworthy witness. It will be found that in the first case the field data are incorrect or otherwise valueless, and that in the second case the field data are generally correct but the identification of specimens is probably or surely at fault. The noteworthy discoveries by others than Carlos Ameghino are:

1. The first remains of *Pyrotherium* were found by Captain Antonio Moreno in the Territory of Neuquén, where they were said to be associated with dinosaurs, the remains of the two having the same aspect. (Ameghino, 1903, p. 19).

2. Remains of a large gravigrade edentate and of dinosaurs were found by Colonel George Rhode in Neuquén, the two being of the same color, aspect, and state of fossilization. Colonel Rhode had also made previous discoveries of the same nature. (Doering, 1882, p. 450; Ameghino, 1885, pp. 153 and 171, 1903, pp. 19–20).

3. Steinfeld and Botello, employees of the Museo de La Plata, found a large mammalian tusk supposedly associated with dinosaurs near Lago Musters. (Moreno and Mercerat, 1890–91, pp. 11–12; Lydekker, 1895, p. 5; Ameghino, 1897, p. 445, 1903, p. 20).

4. Roth claimed to have found mammals of *Notostylops* fauna aspect below a dinosaur (*Genyodectes serus*) near Laguna Pelada in Chubut. (Roth, 1898, pp. 20–21, 1899, p. 382, 1900, p. 263, 1908, p. 96; Ameghino, 1903, pp. 34–36, 1906, pp. 79–80; v. Huene, 1929, pp. 17–18).

5. Roth did find mammals and associated reptiles in sandstone below his so-called "toba cretácea de Dinosaurios" near Gaiman in the valley of the Río Chubut. (Roth, 1899, p. 382, 1908, p. 96 and Plate XVI, Ameghino, 1906, pp. 94–96.)

It is fair and valid to discard the first three observations without much discussion. The field data are lacking or too vague to have any value. In the regions concerned, both *Pyrotherium* and dinosaur-bearing beds are known to occur, but later work has shown them to be at quite

distinct horizons. These horizons were not differentiated by those making the discoveries, who were not trained or even "practical" geologists. The aspect of the fossils, stressed by Ameghino, has no bearing on the problem when not accompanied by other trustworthy data. These three observations must be discarded altogether.

The fourth of the list, the discovery of *Genyodectes serus*, has been adequately discussed by v. Huene (1929, pp. 17–18) who brings out three important points: (a) that the discovery was not made by Roth but by an inexperienced gaucho, (b) that the site is such that the mammals could readily have been derived from a higher horizon than that on which they were found, and (c) that Roth himself was not (in von Huene's opinion) an accurate or able field geologist. The first point in itself invalidates the discovery.

The last citation (5, above) I can myself clearly refute, having studied Roth's collection and visited the locality. Mammals of *Notostylops* fauna aspect were indubitably found at Gaiman in sandstone below the Tertiary tuffs. They are accompanied by reptiles, but Roth himself does not say the reptiles included dinosaurs, and dinosaurs are not, in fact, present in Roth's collection from this locality, now in the Museo de La Plata. Finally, Roth's expression "toba cretácea de Dinosaurios," like the expression "Dinosauriersandstein" later applied to the actual level of the mammals, is used by him as a formation name and neither states nor implies that dinosaurs were actually found in these beds at this locality, and the fact is that they were not so found.

If valid evidence of dinosaurs in the mammal-bearing beds is to be found, it must be in the personal observations of Carlos Ameghino, next to be examined. Authority for reconsideration of these observations is study of all the pertinent materials now in the Ameghino collection, long personal discussion with Carlos Ameghino, detailed field examination of the localities in question, and large new collections from all the geological horizons concerned.

In Ameghino's synthesis of 1903 (pp. 17–45), his arguments are, in brief, (1) that Carlos Ameghino had not found associated mammals and dinosaurs, but (2) that he had found them in the same formation [already discussed above], and (3) that other authorities give instances of such association [also discussed above]. The argument is in part sophistic, in part a valid response to Hatcher's unduly severe and largely inaccurate criticism of Ameghino. The point of most essential value is that at that time Carlos Ameghino had never observed any real or supposed association of dinosaurs and mammals.

In 1906 (p. 80 seq.) Ameghino adds an extremely important point. He can now say what was untrue in 1903, that Carlos Ameghino has now found mammals and dinosaurs not merely in the same (nominal) formation but either at the same level or with dinosaurs above mammals. The actual cases are four in number:

1. At Colhué-Huapí [that is, in the great Barranca (cliff or strip of badlands) south of Lago Colhué-Huapí] a new megalosaur [Ameghino, 1906, Fig. 16] was found in the lower *Notostylops* beds mixed with mammals of that fauna.

2. On the left [northwestern] bank of the Río Chico del Chubut were found remains of dinosaurs of an undetermined and probably new genus associated with mammals in place, including *Carolozittelia tapiroides*.

3. At the same locality remains of *Genyodectes serus* were found at the summit of the *Notostylops* beds above the horizon of *Carolozittelia*.

4. At the same locality *Genyodectes serus* was also found in the *Astraponotus* beds, some forty meters above the level of *Carolozittelia*.

He does not make it absolutely explicit that the last two are separate discoveries, but such was evidently the case. These observations are commonly brushed aside as comparable to the discoveries of Romero, Rhode, etc., but this cannot be done. Here we have circumstantial field data, and the observation was made by an authority to whom his severest critics cannot deny detailed and excellent first-hand acquaint-

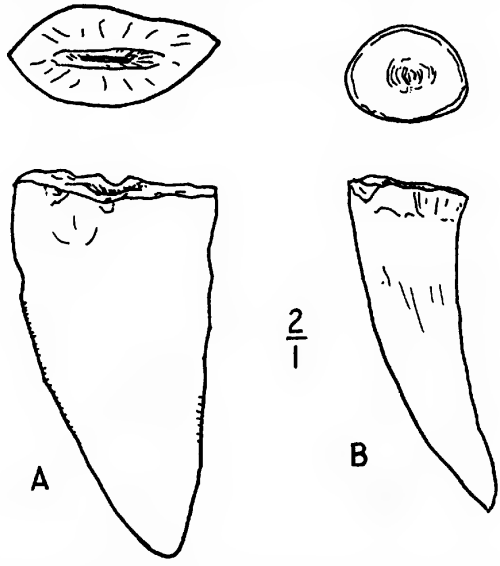


Fig. 4.—Ameghino's supposed dinosaurs from the *Notostylops* Beds. (A), M. N. H. N. No. 10872, from west of the Río Chico. (B), M. N. H. N. No. 10871, from south of Lago Colhué-Huapí. Proximal and lateral views. Twice natural size.

ance with the strata and the ability to discriminate between faunas accurately. It is necessary to assume that the specimens in question did come from the stated horizons unless the opposite can be proven.

Regarding (1), this tooth, supposedly of a new megalosaur, is now No. 10871 of the Museo Nacional in Buenos Aires. Ameghino's figure (1906, Fig. 16) represents it accurately save for an exaggeration of the serrations difficult to avoid in a pen drawing. There is no question that this is a crocodile tooth, and not a dinosaur. (See Fig. 4B). It is curious that another tooth (No. 10885) was identified by Ameghino as *Notosuchus terrestris* although it is practically identical save for its smaller size. This observation, then, falls down through incorrect identification.

Regarding (2), (3), and (4), these observations, all at one locality, must be based on at least three specimens (just three, I believe). Only one of them is now to be found in the Museo Nacional. It is No. 10872 and bears the data in Ameghino's hand "Dinosaurio O. Río Chico *Notostylops*," i.e., a dinosaur from west of the Río Chico del Chubut in the *Notostylops* beds. It is probably the tooth referred to in (3), as it is labeled from the *Notostylops* beds and resembles *Genyodectes serus* as closely as it does any other dinosaur. (See Fig. 4A). As this is the only specimen now available, it reasonably becomes a test case on which the whole argument stands or falls, especially as Carlos Ameghino says (personal communication) that the missing specimens were similar in nature.

This tooth was discussed by von Huene (1929, p. 18, paragraph *C*), who states that it was not mentioned recognizably in any of Ameghino's writings. He also states that Carlos Ameghino did not remember finding it, that its horizon was probably judged from preservation and not from the field data, that in any event Carlos Ameghino is only a "práctico" (unlearned worker by rule of thumb rather than a trained geologist), that Florentino Ameghino several times changed data of origin in successive publications, and that there are no *Notostylops* beds in this region. He agrees that the tooth is dinosaurian but concludes that it came from the "Pehuenche."

It has already been shown that the tooth is mentioned, identified, and its horizon defined by Ameghino (1906, pp. 80–81), and don Carlos (recently recovered from a very severe illness) remembers the discovery distinctly. Its horizon was not judged by preservation, but by field observation and association with mammals of known age. I have already expressed my broadly founded admiration for the work of Carlos Ameghino, not merely as a "práctico" but practical in the better

English sense of the word. As he rightly insisted in his defense against Hatcher's attack, Ameghino's changes of data were those usual in all work with increasing precision in the distinguishing of separate faunas or faunules. Finally, there certainly are *Notostylops* beds in this region, for we have literally hundreds of specimens from it including *Notostylops*

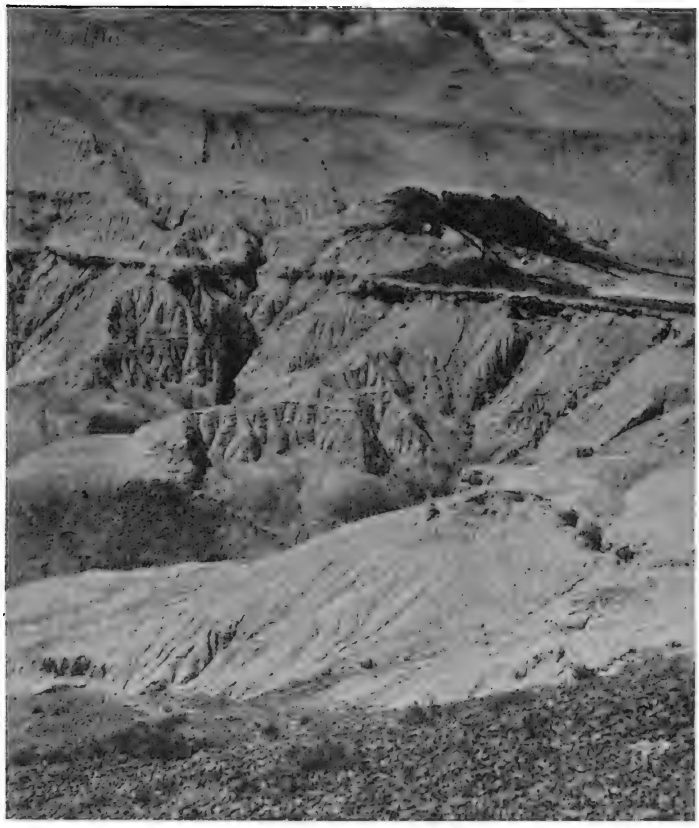


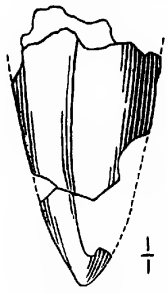
Fig. 5.—*Notostylops* Beds overlying sterile clays in the Oficina del Diablo, Cañadón Vaca. *Florentinoameghinia* was found in the massive bed about fifteen feet thick between the hard bench above, and the thin-bedded sand and tuff below. Typical mammals of *Notostylops* age occur at, slightly below, and through a great thickness above the same horizon.

itself and numerous other genera typical of that horizon. To clinch the matter, we exactly repeated the observation: in this same general region west of the Río Chico we found a tooth nearly identical with that mentioned by Ameghino, still partly buried in undisturbed matrix, with-

in a few inches of mammal teeth and at and above levels with numerous mammals surely of *Notostylops* age.

The stratigraphic data are therefore correct beyond any doubt, and it is necessary to conclude: that dinosaurs do occur in the *Notostylops* beds, that the identification by Ameghino and von Huene is incorrect, or that the specimens are derived from older beds.

Derivation from older beds must be discarded here as very unlikely. The teeth, which are fragile and delicately sculptured, show no signs of rolling. The repetition of the discovery much reduces the chances of secondary derivation. Among the numerous other specimens found, there is none that seems to be derived from older beds. The strata for some distance below do not contain any dinosaurs so far as known. The sediments of this bed differ materially from those of any known dinosaur-bearing beds of the region and give no evidence of containing materials *remaniés* from the latter.



A.M. 28401

Fig. 6.–*Florentinoameghinia mystica?*, Amer. Mus. No. 28401, canine tooth probably associated with the type of this species and closely resembling the original of Fig. 4A. Lateral view.

The characters of the teeth themselves are sufficiently clear in the accompanying figures (Figs. 4A, 6). The enamel is very thin, nearly smooth, but with delicate, almost microscopic irregularities. The secant edges are very finely and irregularly serrated. The evidence as to the identification of these teeth may be summed up as follows:

1. The teeth are not exactly like those of *Genyodectes serus* (a true carnivorous saurischian) or of any other known dinosaur. It is equally true that they are not identical with those of any other known group, but they are as much like some mammals as they are like dinosaurs.

2. At least two thousand individual specimens have been collected from the *Notostylops* beds and many others seen but not collected. Among these there is not a single skeleton bone or bone fragment that could possibly belong to a dinosaur. In every known formation surely containing dinosaurs, bones are much more abundant than are teeth.

3. Numerous thin sections were made and carefully studied. These were inconclusive to the extent that no infallible criterion seems to separate all dinosaur teeth from those of any other vertebrates, and particularly mammals, but the enamel structure of these teeth was not exactly matched in any dinosaur examined and was quite indistinguishable from some mammalian sections.

4. Our own specimen was found very close to cheek teeth clearly mammalian. This again is not conclusive, because the same block of matrix contained remains of at least two other mammals, and positive contact could not be established by reunion of the crushed fragments. It is, however, strongly suggestive, because: (a) these cheek

teeth, although scattered in the matrix to some extent, represent a characteristic part of the upper jaw of a single individual, whereas the others present were mere random fragments and were not so near the "dinosaur" tooth; (b) the size relations are fully possible for association of the caniniform and upper cheek teeth; (c) the cheek teeth represent an animal excessively rare in the formation and very peculiar in character, which is likewise true of the caniniform "dinosaur" tooth, and (d) the caniniform tooth was implanted in a fragment of bone identical in texture, density, preservation, etc., with bone undoubtedly associated with the cheek teeth and unlike other random bone fragments in the vicinity. These facts seem to me to establish a very strong probability that the "dinosaur" tooth belongs to the mammal represented by the cheek teeth.

Even without adding the *a priori* improbability of these being dinosaur teeth to these considerations, as would be logically permissible, it is clear that the weight of evidence is very definitely opposed to the identification of these caniniform teeth as those of dinosaurs. The only reasonable theory is that they do not represent dinosaurs. With the further analysis of other evidence previously given, the whole theory of the association of ungulates and other mammals of Tertiary type with dinosaurs in Patagonia falls down, together with all the elaborate hypotheses invented to explain it or reared on it as a foundation.

In the *Notostylops* beds and also in the *Astraponotus* beds we found other teeth quite as dinosaur-like as M. N. H. N. No. 10871 and nearly as much so as No. 10872. Without exception these can definitely be shown by direct comparison, by association, or by microscopic structure to be either of crocodiles, sparassodonts, or ungulates.

At the present time there is no evidence for the association of dinosaurs and ungulates in Patagonia. Ungulates (and the other apparently exclusively Cenozoic groups) cannot have appeared suddenly and without antecedents. In the late Mesozoic they were somewhere, but there is no evidence at all that it was in Patagonia rather than any other part of the world. Nor is it wholly unlikely that some dinosaurs straggled on into the Cenozoic somewhere, but here again there is a total lack of evidence, especially in Patagonia where they have not yet been surely shown to have survived to the end of the Senonian.[1]

A NEW PATAGONIAN FOSSIL MAMMAL

The curious cheek teeth found with and probably associated with the caniniform, more or less dinosaur-like tooth discussed above are of so much interest in connection with the subject of this paper that they may well be named and briefly described at this time.

[1] In view of the argument as to whether dinosaurs survived longest in South America, it is a curious but probably accidental aspect of the evidence at hand that indubitable dinosaurs are actually known at a later period in North America than in South America.

FLORENTINOAMEGHINIA,[1] new genus

TYPE.—F. *mystica*, new species.

DISTRIBUTION.—*Notostylops* beds, Patagonia.

DIAGNOSIS.—A Patagonian fossil mammal of uncertain affinities. Upper molariform teeth with subequal, well separated paracone and metacone. Protocone and hypocone about equal, partly connate (more anteriorly) to well separate. Proto- and metaconules almost as large as proto- and hypocones and tending to form cross crests with the latter and the para- and metacones. Metaconule partly connate with hypocone and not at all with protocone. No mesostyles. Anterior and posterior, but no internal, cingula.

Florentinoameghinia mystica, new species

TYPE.—Amer. Mus. No. 28402. Three somewhat imperfect upper cheek teeth, with associated skull fragments. Probably associated also with Amer. Mus. No. 28401, caniniform tooth.

HORIZON AND LOCALITY.—*Notostylops* Beds,[2] Oficina del Diablo, Cañadón Vaca, near Paso Niemann of the Río Chico del Chubut, Chubut Territory, Argentina.

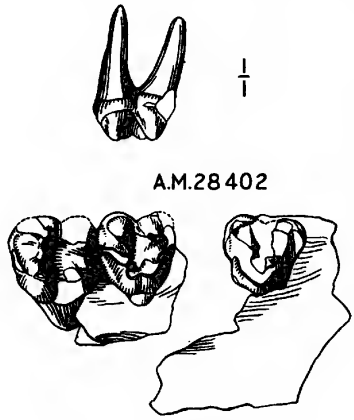


Fig. 7.—*Florentinoameghinia mystica*, new genus and species. Amer. Mus. No. 28402. Two fragments of the right upper jaw with three teeth, crown views, and external view of most complete tooth, M^1?.

DIAGNOSIS.—Sole known species of the genus. ?M^1 measures 10 mm. in both dimensions.

The remains surely belonging to this individual were scattered through about a cubic decimeter of matrix, which also contained the caniniform tooth mentioned above. In addition to several skull fragments showing little distinctive character and without certain mutual contacts, it was possible to piece together two sections of the right maxilla, one containing two teeth, the other one. These two fragments do not indubitably contact, but were apparently contiguous either immediately or with one intermediate tooth.

The most anterior of the three preserved teeth was preceded by a diastema. Nearly five millimeters of the dental border are preserved, and there is no alveolus. The tooth is triangular and nearly equidimensional, about 10 mm. long and wide. The protocone is of the common crescentic type, and there is no hypocone. The metacone is subconical, crested antero- and posteroexternally. The paracone is broken away, but from its emplacement was about equal to the metacone. The protoconule is of moderate size and imperfectly separated from the protocone. The metaconule is not preserved, and may have been smaller. This tooth is probably either P^3 or P^4.

[1] It is simple justice that Ameghino's series of nomenclatural curiosities, *Asmithwoodwardia*, *Henricosbornia*, *Guilielmofloweria*, *Edvardotrouessartia*, and the like, for mammals of this age should terminate with one dedicated to himself.

[2] More exact stratigraphic data will be given in a later paper.

The first of the two teeth preserved in contact is perhaps M^1, for it is molariform but with protocone and metacone more connate than in the following tooth and is more worn than the latter. Its dimensions are those of the triangular tooth just described, but the form is different, more trapeziform. The nearly equal paracone and metacone are the highest cusps, well separated by a deep notch, subconical, and somewhat compressed transversely. The equal protocone and hypocone have connate bases. Nearly as large as these are the protoconule and metaconule, wedged between them and the paracone and metacone respectively, and tending thus to form transverse lophs. There are external, anterior, and posterior cingula of moderate development, without distinct cusps or styles and not extending onto the inner face. There is no mesostyle; on the contrary, there is here a sharp notch in the outer border. The middle of the crown is occupied by a basin, closed all around.

The following tooth, perhaps M^2, is imperfectly preserved but reveals its chief characters. It is larger than that preceding it and more quadrate, the inner side about as long as the outer. The external cingulum was probably weaker, and, as before, there is no internal cingulum, but anterior and posterior cingula are somewhat wider and almost basined. The protocone and hypocone are here well separated, and the cusps tend to form two parallel transverse lophs, each composed of three nearly equal cusps with connate bases.

Above the last two teeth described (but not the first) there are large sinuses, separated by a very thin partition. Those may be the crypts of successional teeth, especially as the bone does not seem fully mature, but the probabilities are somewhat against this as they are not quite of the expected character and the teeth in use are little worn and otherwise without definite suggestion of being milk teeth.

There was a foramen of considerable size internal to a point between the two cheek teeth preserved together, piercing the palate obliquely upward and backward. The other fragments include part of the brain case and an adjoining large sinus, the bone pierced by several foramina and canals but the surface nearly flat, as if from the skull roof. Neither this nor the other parts preserved can be exactly placed.

Of this animal just enough is preserved to show that it is new and very strange, just too little to give a firm basis for conjecture as to its affinities. There is nothing in the Ameghino collection that can be closely compared, and even the probable addition of the strange sabre-like canine hardly adds to its isolation.

It is obviously not a notoungulate, having not one of the characters so clearly distinguishing upper cheek teeth of that group, whether primitive or advanced and regardless of the divergent specializations of the anterior dentition. The large hypocones, tendency to form transverse lophs, and absence of oblique shear make affinity with the carnivorous marsupials extremely improbable, and resemblance to other South American marsupials is even more remote. The only comparisons that appear to be suggestive, and even these not more than suggestive, are with the Litopterna and Pyrotheria. Aside from numerous other distinctions, even those primitive litopterns most nearly comparable retain the

trigon as an entity, with the hypocone added on and distinct, while here the trigon is wholly effaced and the metaconule is not at all related to the protocone but only to the metacone and hypocone. The difference is fundamental, yet a relationship is conceivable. The incomplete most posterior tooth of the three does suggest the most primitive true pyrothere, *Carolozittelia*, the structure of which would be almost duplicated by slight further development of the lophs and merging of cusp individuality. But this and other comparisons do not warrant even a hypothesis of relationship.

REFERENCES

AMEGHINO, F. 1885. Nuevos restos de mamíferos fósiles oligocenos recogidos por el profesor Pedro Scalabrini y pertenecientes al museo provincial de la ciudad de Paraná. Bol. Acad., Nac. Ci. Córdoba, VIII, pp. 5–207.

1897. Mammifères crétacés de l'Argentine. (Deuxième contribution à la connaissance de la faune mammalogique des couches à Pyrotherium). Bol. Inst. Geog. Arg., XVIII, pp. 406–429, 431–521. [Also issued as a separate, pp. 1–117.]

1903. L'Age des formations sédimentaires de Patagonie. An. Soc. Ci. Arg., L and LIV. [Also as a separate, pp. 1–231—this edition used in preparing the present paper.]

1906. Les formations sédimentaires du Crétacé supérieur et du Tertiaire de Patagonie avec un parallèle entre leurs faunes mammalogiques et celles de l'ancien continent. An. Mus. Nac. Buenos Aires (Ser. 3ª, VIII), pp. 1–568.

DOERING, A. 1882. Expedición al Río Negro. III, Geología.

FERUGLIO, E. 1931. Nuevas observaciones geológicas en la Patagonia Central. Direc. Gen. Yac. Petrol. Fisc., Cont. 1ª Reun. Nac. Geog., No. IV, pp. 1–24.

HUENE, F. VON. 1929. Los saurisquios y ornitisquios del Cretáceo Argentino. An. Mus. La Plata, (2) III, pp. 1–196.

LYDEKKER, R. 1895. Supplemental observations on the extinct ungulates of Argentina. An. Mus. La Plata, III, Part II, No. 1.

MORENO, F., AND A. MERCERAT. 1890–91. Catálogo de los pájaros fósiles de la República Argentina conservados en el Museo de La Plata. An. Mus. La Plata, Paleont. Arg., I, pp. 7–71.

PIÁTNITZKY, A. 1931. Observaciones estratigráficas sobre las tobas con mamíferos del Terciario inferior en el Valle del Río Chico (Chubut). Bol. Inf. Petrol., VIII, No. 85, pp. 1–16.

ROTH, S. 1898. Apuntes sobre la geología y la paleontología de los territorios del Río Negro y Neuquén. Reconocimiento de la región andina de la Rep. Arg., Mus. La Plata, pp. 3–56.

1899. Aviso preliminar sobre mamíferos mesozóicos encontrados en Patagonia. Rev. Mus. La Plata, IX, pp. 381–388. [Also as a separate, pp. 1–18].

1900. Some remarks on the latest publications of Florentino Ameghino. Amer. Jour. Sci., (4) IX, pp. 261–266.

1908. Beitrag zur Gliederung der Sedimentablagerungen in Patagonien und der Pampasregion. N. Jarhb. Min. Geol. Pal., Beil. Bd. XXVI, pp. 92–150.